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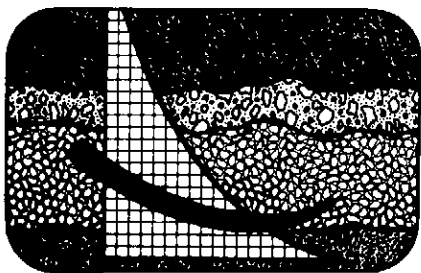
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Absolute Dating and Isotopic Analyses in Prehistory; Methods and Limits

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After many different dating methods had been applied to the cave deposits in the cave of Caune de l'Arago near Tautavel, Pyrenees-Orientales, France, Prof. Henri de Lumley (now of the Museum d'Histoire Naturelle, Paris) held a colloquium from June 22nd to 28th, 1981 to discuss the results. Some 60 French scholars who were actively engaged in the study of the site, along with representatives from Great Britain, Canada and the USA inundated the small town for the conference. Although the idea was an excellent one, the conference was hampered from the outset by several problems.

One of the most exasperating problems was the poor translation of talks. Although the amateur translators did their utmost, they were not able always to make an exact translation of the sense of many presentations, and during the discussion which followed each paper, many of the comments were not translated at all. Professional translators are essential for the success of such a colloquium.

Secondly, many of the scientists who were attempting to date the site had not seen the cave prior to the conference. Therefore, they had little understanding of the problems. This was further compounded by the fact that some of the samples given to the various international laboratories were not accompanied by proper coordinates of their locations within the cave. Hence, it was impossible for the researchers to compare dates with those of others. Furthermore, because much of the site has not been excavated, the stratigraphy is not completely understood. Many of the excavators had preconceived ideas regarding the history, stratigraphy, and most importantly, the

age of the site. When evidence to the contrary was presented, it was often completely ignored, or dismissed.

Thirdly, several investigators who presented dates did not appreciate the limits of their methods. Dates were quoted which exceeded the possible dating range of the method being applied! Unfortunately, one such date was announced to the public in a televised interview before it could be properly discussed. Although it was later refuted and withdrawn, the date was printed in several newspapers and they are unlikely ever to print the rebuttal.

Regardless of these problems, the people involved did communicate some important information and presented new data. Several new techniques along with their problems were discussed.

The first morning, several dignitaries welcomed the guests followed by a reception at the town hall, and a visit to the new museum where artefacts from the site were displayed. That afternoon the entire group visited the cave for an introduction, by Henri de Lumley, to the stratigraphy. For many, this was their first view of the cave. In the final session, there was a lively discussion of the stratigraphic problems.

The first technical session covered the geochemistry and geomorphology of the cave fill. G. Perinet and R. Lafont showed that the source of the extensive phosphatization in the sediment was not derived from bat guano, but from the dissolution of bones found in the upper layers. In contrast B. Guillet *et al.*, claimed that because of the quantity of phosphate present, it had been derived from bat guano. The source of phosphate and its role in diagenesis are crucial to the history of sedimentation and to the interpretation of dating results. Therefore, the discussions which followed these papers were heated. A Cornu *et al.*, showed that most of the quartz present in the cave originated from the sands found on the overlying plateau.

Discussions of the flora, fauna, and magnetostratigraphy of the cave followed in the second session. Papers by L. Jordan and A. Moigne, and C. Guerin showed that the deposits were late Mindel in age, but could not be more precisely dated by the large mammal fauna. J. Chaline, however, argued that the microfauna indicated that the age should be equivalent to that of isotope stage 10 or younger. B. Kurtén's and H. Kahlke's papers indicated similar results. J. Renault-Miskovsky's pollen data further confirmed a cold climatic period, probably representing only one interglacial period. The magnetostratigraphic results of V. Nguyen were inconclusive.

The third and fourth sessions consisted of a discussion of the U-series dates for the site. C. Lalou and C. Hoang, and J. Bischoff and R. Rosenbauer dated both the travertine deposits and the bones in the site, while K. Turekian and J. Cochran, H. Schwarcz and B. Blackwell, N. Debenham *et al.*, and G. Henning *et al.*, dated only the travertines. With the exception of Bischoff's work, all the dates for Unit 4 agreed within the analytical error limits. Many levels, however, appear to be leached of uranium or thorium, which resulted in spuriously ages, and inconsistent results. Y. Yokoyama and V. Nguyen presented a controversial attempt to date the Arago XXI skull directly by non destructive x-ray spectroscopy.

The fifth session on thermoluminescence (TL) hinted at the problems associated with this method. After M. Aitken introduced the method, G. Valladas *et al.* stressed the problem of estimating the annual dose rate in calculating the age, while Debenham *et al.* stressed that the non-uniformity of the calcite crystals in the Arago samples affected the emission of the TL signal. These preliminary results, along with those of M. Ota and W. Herr *et al.* suggest that the TL dates will be in reasonable agreement with the U-series dates.

The relatively new method of Electron Spin Resonance (ESR) prompted a lively discussion in the next session. In his introduction, M. Ikeya stated that the method could be used to derive valid dates. G. Robins *et al.*, however, held that it was impossible to use ESR for absolute dating because of uncertainties in estimating the values of the various quantum mechanical functions. M. Ikeya and T. Miki discussed several problems arising from fossilization of the bones, and difficulties in calculating the annual dose rate for the levels. In the future, when this method is perfected, it may provide some interesting results for archeological sites.

Amino acid racemization dating was introduced by J. Bada. Papers by J. Bada *et al.*, G. Smith *et al.*, N. Rutter *et al.*, P. Wanet *et al.*, and R. Lafont *et al.* showed good agreement for the D/L ratios of aspartic acid, which do not vary significantly with depth in Units 1 through 3. Each paper also illustrated some of the problems encountered in obtaining a date from these ratios. T. Molleson, and A. de Ricquès *et al.*, both discussed how fossilization of bones could affect the biochemistry of the bones used in the method. Finally, R. Rottländer discussed the possible uses of fatty acid residues in order to determine species of the animals consumed.

The conference concluded with a review summary of each session and an overall discussion of the results. Although we appear no closer to an absolute age determination of the controversial hominid remains from the site, many of the problems were shown to be a result of the nature of the site and not from the methods employed by any particular laboratory. Furthermore, many of the problems involved in dating archeological sites absolutely were finally brought home to everyone present, especially the archeologists. These included: 1) The need to full understand the limits and limitations of any dating method used; 2) Standard error limits must not be ignored in utilizing dates; 3) Samples should be collected with both the archeologists and the dating experts present to ensure that the best possible samples are chosen, and to foster an understanding of the site and its particular problems; 4) New dating methods, their applicability, and limits should be tested first in simple situations, before being used at Arago, where the complexities of the site make it impossible to ascertain whether the fault lies with the method or the samples.

Some time in 1982, a summary volume of the conference papers, including the discussions which followed each paper, should be available from the CNRS.

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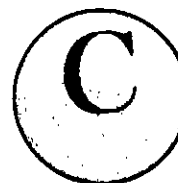
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